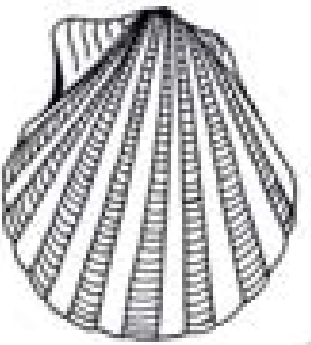
Identification Guide to the Fossils of Guadalupe Mountains National Park



Mary Carol Coleman and Cameron Coleman

PREFACE

This Identification Guide to the Fossils of the Guadalupe Mountains has been compiled in the hope that it will help visitors gain a greater appreciation and understanding of the mountains as they are today and of the sea, plants, and animals that formed them so many millions of years ago.

We hope that the increased knowledge this volume can provide will lead to an enhanced reverence for and protection of this unique and fragile resource.

This guide is not intended to be comprehensive, but includes the fossils that would most frequently be found.

WHY STUDY THE ROCKS?

Scientists don't just study the rocks and their fossils to learn about ancient life and long-passed environments. For decades the rocks and fossils of the Guadalupe Mountains and Delaware Mountains to the south have been studied by geologists in an attempt to better understand how petroleum deposits were formed and how to tap into those deposits. The extensive oil fields of the west Texas Permian Basin were developed primarily by applying what was learned from these studies. Petroleum deposits have and are being found today in many other regions of the world because of geology lessons learned here.

PROTECTION OF THE FOSSILS

The Guadalupe Mountains are a world-class example of a marine reef of the Permian period. Our study of the fossils here is an attempt to step back into a time that will always partially remain a mystery to us. Most of the plants and animals that have turned into rock are long since extinct. We can never know the reef as it was when it was filled with living creatures, bathed in ancient seawater. However, by painstaking, prolonged study of the rocks that remain, some of the secrets of the life of the reef and the surrounding sea are being revealed to us.

The fossils that are here have meaning only in the context of the land from which they came. We ask that you respect and care for the fossils by leaving them where you find them. Every fossil or rock that is illegally removed from the Park is a potential loss of a piece of the puzzle. Penalties for removal of or damage to any rocks in the park can include fines of up to $5000 and six months in jail. Damage includes scratching names or dates or pounding with other rocks.

Please report anyone damaging or removing fossils to park rangers.

GEOLOGIC HISTORY

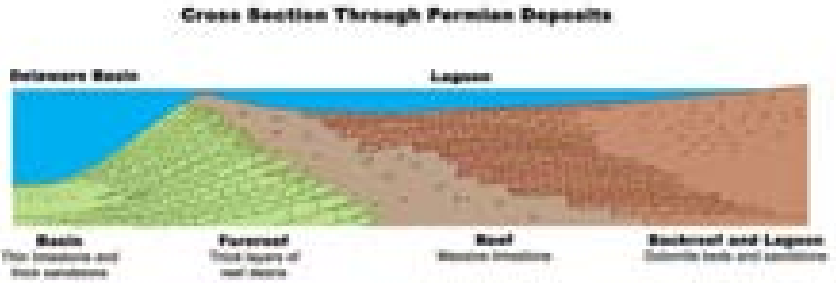
The Guadalupe Mountains originated as a marine reef in the Permian Period – 280 to 250 million years ago. Most of the earth's land mass at that time was united in the supercontinent of Pangaea (meaning "all lands"). What is now western Texas lay near the western edge of Pangaea and was at the time about 5 degrees north of the equator. The collision of the continents during the formation of Pangaea had caused a large area to warp downward to form the Permian Basin and seawater had filled this basin. The marine reef grew along the edges of a portion of this seaway that we today call the Delaware Sea. Over millions of years the reef became a massive structure about 400 miles in length, completely encircling the edges of the deep Delaware Basin.

The reef was formed by many organisms that are extinct today, even though most do have living relatives. Unlike modern reefs which are composed primarily of colonial corals, the predominant organisms of the Capitan Reef were many different kinds of sponges. Numerous species of algae, bryozoans, cephalopods, crinoids, trilobites, brachiopods, horn corals, and fusulinids also lived on this reef. As these organisms died, they left a skeletal framework, cemented together by algae, on which their successors could continue to grow. The reef thus gradually built upward and outward into the deep basin, being further hardened by the precipitation of calcium carbonate from seawater.

Over time, waves washed billions of organisms off the surface of the reef and unstable sections of the reef broke off. These large and small fragments slid down the reef front, forming a slope below the reef called the forereef. The reef also grew high enough to block free flow of seawater behind it, so a shallow lagoon was formed that stretched for ten miles between the reef and the shore. High evaporation rates in this equatorial climate caused minerals in the waters of the lagoon to become concentrated and deposit layers of rock called dolomite.

Toward the end of the Permian Period, the Delaware Sea began to dry up, the reef died, and the basin filled in with salts and sediments. The dead reef was buried, and the plants and animals that had lived and died there over millions of years were encased and turned into rock, as well as deposits of petroleum. Soon after, some form of cataclysmic event caused the Permian Extinction, in which 95% of all life on earth perished. Many of the types of organisms that had built the reef became extinct.

About six million years ago, shifts in the earth's crust along fault lines caused the long-buried reef to be lifted upward to its present position. Exposed to weather, the salts and softer sediments were washed away, leaving the ancient reef towering over the basin floor. During the last Ice Age, large amounts of rushing water carved canyons through the reef, revealing it in cross-section and shaping the Guadalupe Mountains as we know them today.



ALGAE

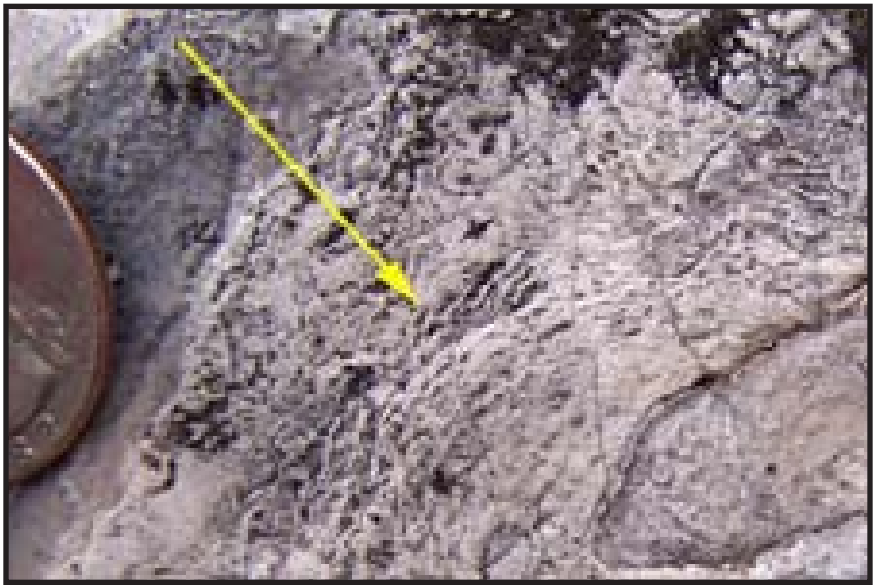
Fossil identification

- Looks like thin, multiple, uniform layers; may be straight, tightly curved, or stacked
- May surround another organism
- Sometimes looks like a sliced cabbage head
- Found in reef or forereef, on sides of canyons or Southeast escarpment

Biological Data

- Belong to a very large group of simple plants lacking roots, stems, and leaves
- Blue-green algae probably ancestral to all higher plants
- Includes seaweeds
- About a dozen types of algal fossils identified in the Guadalupes
- All genera found here now extinct

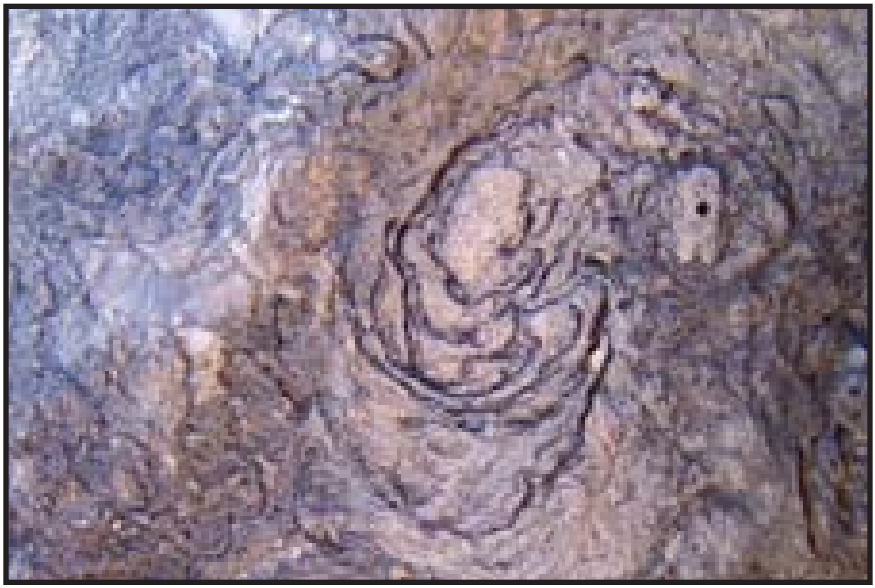
ALGAE



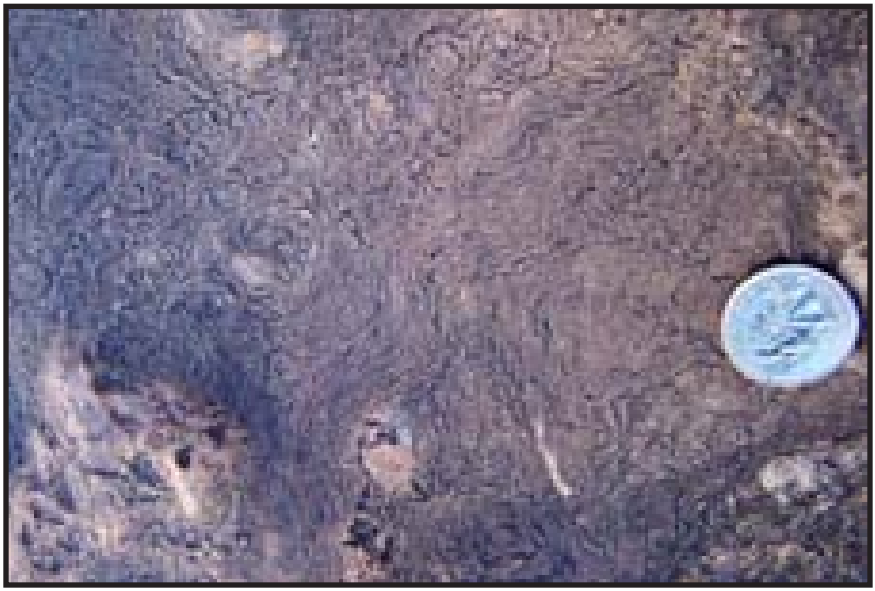
algae - Archaeolithoporella

algae - Collenella

ALGAE



algae - Archaeolithoporella



algae - Archaeolithoporella

AMMONOIDS

Fossil Identification

- Coiled in one plane with internal chambers
- Chamber partitions are wavy or complicated
- Sometimes hard to distinguish from a nautiloid if the partitions are not readily visible
- Internal canal present but not easily visible
- Found in many places, but always uncommon

Biological Data

- Survived the Permian Extinction but became extinct along with the dinosaurs 65 million years ago
- Were a type of cephalopod, related to squids and octopi
- Had a chambered shell, into which they pumped gas to rise or descend in the water
- Tentacles seized prey and held it to jaws
- Important in identifying the age of rocks worldwide

Exterior - without visible partitions

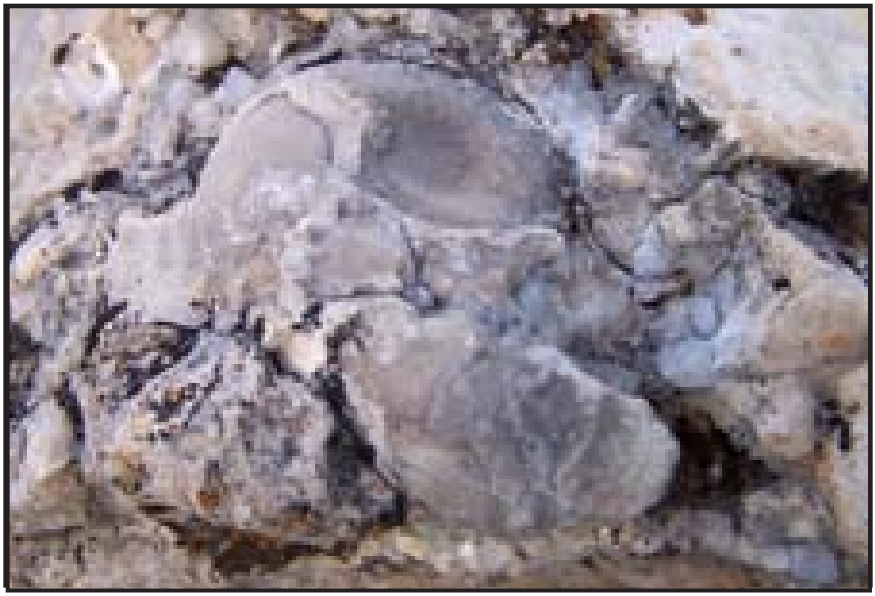
AMMONOIDS

Interior - with partitions

Interior - with partitions and furrows

AMMONOIDS

vertical cross section



Lurking Ammonoid - partially obscured by rock

AMMONOIDS

horizontal cross section

NAUTILOIDS

Fossil Identification

- Coiled in one plane with internal chambers
- Chamber partitions gently curved; not wavy
- Partitions relatively close together
- Sides may be smooth or with regularly placed bumps
- Internal canal often present and located more centrally that in ammonoids
- Found mainly in reef just below crests of ridgelines and canyon walls

Biological Data

- Still represented today in the Chambered Nautilus
- Soft anatomy similar to ammonoids

External mold showing bumps and preserving a portion of the body cavity (right)

NAUTILOIDS

Vertical cross section showing interior partitions and open chambers

partial cross section showing open chambers, filled chambers, and internal canal (marked with arrow)

NAUTILOIDS

horizontal cross section - note central position of canal (marked with arrow)

cross section - with canal (marked by arrow)

GASTROPODS

Fossil Identification

- Coiled snail
- Lacks cross chambers of ammonoid and nautiloid
- Coiling often in more than one plane

Biological Data

- Still exist today as snails, whelks, and conchs
- Is a mollusc with a head, a foot, and a coiled shell
- Branch of ancestral form probably evolved into nautiloids
- Feed by grazing on algae, decaying organisms, or bacterial slime

cross section - note lack of chambers/partitions

GASTROPODS

Original color stripes preserved

GASTROPODS

cross section - no chambers/partitions

vertical cross section

BRACHIOPODS

Fossil Identification

- Bivalve; bilaterally symmetrical
- Often with strong, radiating ridges
- Common
- Can occur in large clusters
- Found mainly on the mountain flanks, or in the foothills; can often be found in washes

Biological Data

- Have living representatives living in oceans
- All but one group died out during Permian Extinction
- Attach to substrate by stout muscular stalk at posterior end
- Feed by action of cilia sweeping minute organisms into mouth
- Sometimes found in large clusters

BRACHIOPODS

Collemataria - “Dead Men’s Chests”

BRACHIOPODS

BRACHIOPODS

A cluster of several kinds of brachiopods; all partially exposed

a bed of brachiopods

PELECYPODS

Fossil Identification

- Bivalve; not bilaterally symmetrical
- An example – an oyster or typical beach shells
- Not common; but when found occur mostly in reef and shelf rocks directly above reef high on canyon and escarpment slopes

Biological Data

- Modern-day representatives are clams, oysters, and scallops
- Most burrow in sand or mud using fleshy foot
- Few attach to substrate like mussels
- Feed by filtering microorganisms out of water or mud

an “oyster” type - very rare

PELECYPODS

an “ark” type

burrowing clam

BRYOZOANS

Biological Data

- Have living representatives living in oceans
- Colonial animals form structures containing thousands of identical individuals
- Each individual lives in separate protective case
- Colony grows by budding
- May appear plant-like or net-like
- Ciliated tentacles emerge from opening to sweep water into mouth, filtering out
- microorganisms

BRYOZOANS

Encrusting

Fossil Identification

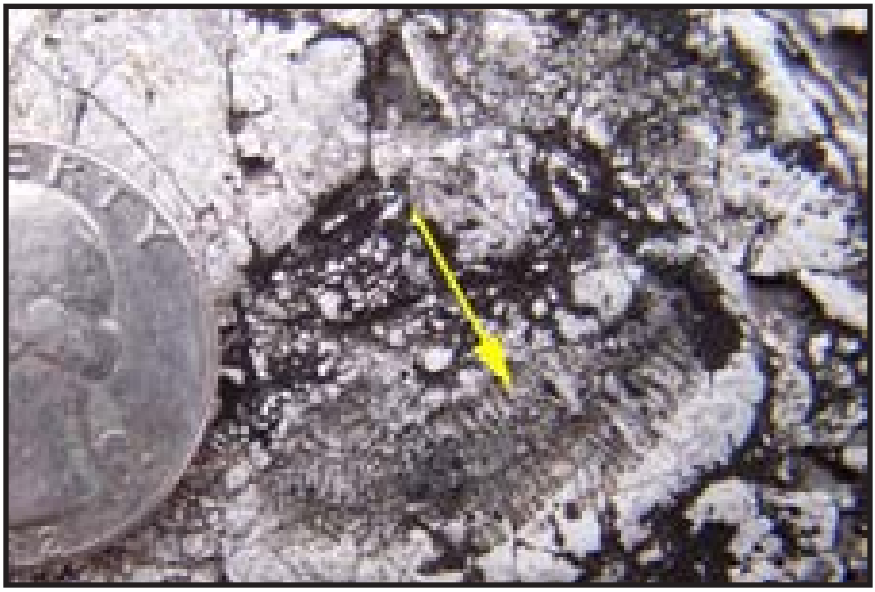
- Lots of small, closely packed regular tubes surrounding another organism

Bryozoan completely surrounding a sponge (*Colospongia*)

BRYOZOANS

Encrusting

Bryozoan encrusting top of branched sponge



Bryozoan encrusting granular material

BRYOZOANS

Fenestrate

Fossil Identification

- Net-like appearance; small, regular chambers
- Can spread out and appear fan-like or funnel shaped

BRYOZOANS

Fenestrate

BRYOZOANS

Ramose

Fossil Identification

- Looks like lots of small radiating tubes

red arrow points to a *Colospongia*; yellow arrow indicates the bryozoan

BRYOZOANS

Stick-shaped

Fossil Identification

- looks like a spiny stick

red arrow points to sponge; yellow arrow indicates Bryozoan

CORALS

Horn corals

Fossil Identification

- Single animal; not colonial
- Appears as numerous blades or plates that radiate outward from central area which may be open or filled
- Blades get thicker as they approach outer walls
- Small plates may connect the blades
- Exterior may show numerous parallel lines
- Horizontal central chambers may be present
- Cross section can be ¼ to 1 ¼ inch

Biological Data

- Died out during Permian Extinction
- A coelenterate, distantly related to modern corals and jellyfish
- Anchored itself to sea floor or substrate
- Algae in tissues secrete hard protective horn-shaped skeleton

cross section

CORALS

Horn corals

cross section

CORALS

Tabulate

Fossil Identification

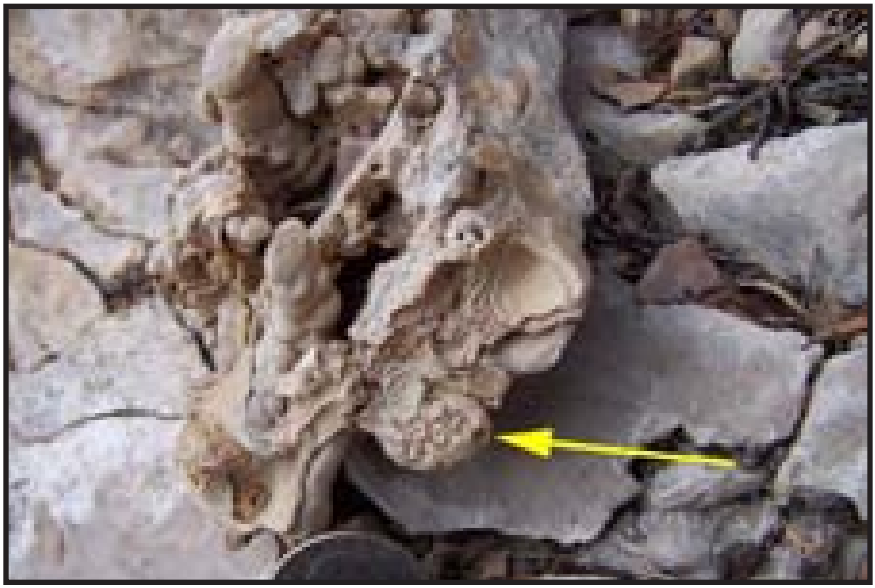
- Looks like small wasp nest; ¼ to ½” diameter; spherical shape
- Cells are approximately 1/8” across; larger than bryozoan cells (bryozoan cells are smaller and more uniform in size and position)
- Cells may be covered with flat cap and are polygonal in shape
- Colonial coral

Biological Data

- Extinct
- Distantly related to modern corals and jellyfish
- Formed dime-sized globular colonies that attached high on other organisms
- Only colonial coral found on Capitan Reef

CORALS

Tabulate



yellow arrow points out coral; rest of rock is sponges

CRINOIDS

Fossil Identification

- May occur as numerous individuals in large patch
- Sectioned stem
- Branching head is not usually found
- Usually solid, crystalline calcite
- Cross section appears amorphous in texture

Biological Data

- An echinoderm, distantly related to starfish, sea urchins, and sand dollars
- Attach by stalk to substrate
- Skeleton consists of close-fitted plates, each being a single flat calcite crystal
- Have rare modern representatives, inhabiting deep sea bottoms
- Have a nervous system and a one-way digestive tract
- Use branched arms to filter small organisms from water

CRINOIDS

CRINOIDS

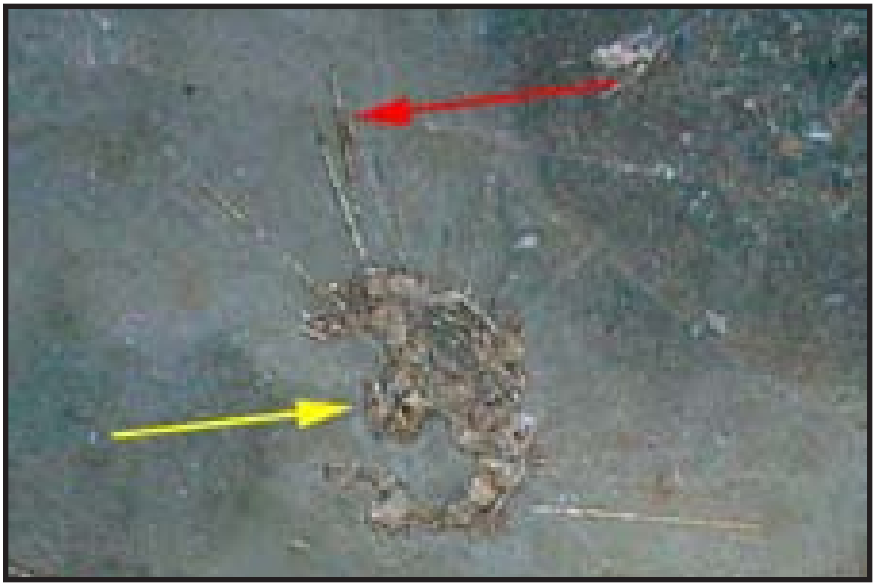
ECHINOIDS

Fossil Identification

- Sea urchins
- Balls of plates with long spines

Biological Data

- Have modern representatives in sea urchins and sand dollars
- Related to starfish and crinoids
- Have long, sharp spines and close-fitted plates enclosing soft body parts
- Mouth in center of lower surface
- Move with tube feet which project through holes
- Graze on vegetation and dead material



yellow arrow points to body; red arrow points to spines

ECHINOIDS

spine

FUSULINIDS

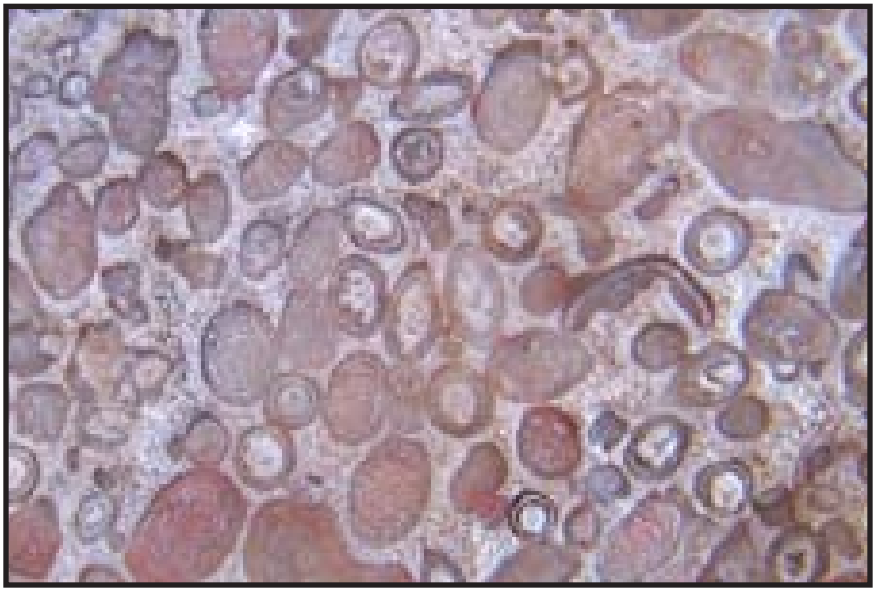
Fossil Identification

- Single cell organism covered with porous shell
- Look like large grains of rice
- Found in large numbers at the top of the reef; higher elevations
- Complex internal structures

Biological Data

- Died out during Permian extinction
- Living relatives known as Foraminifera
- Single-celled protozoan which secretes a mineral shell
- Pseudopods extended out through porous shell to absorb food and provide locomotion
- Millions lived on landward side of reef

FUSULINIDS



FUSULINIDS

SCAPHOPODS

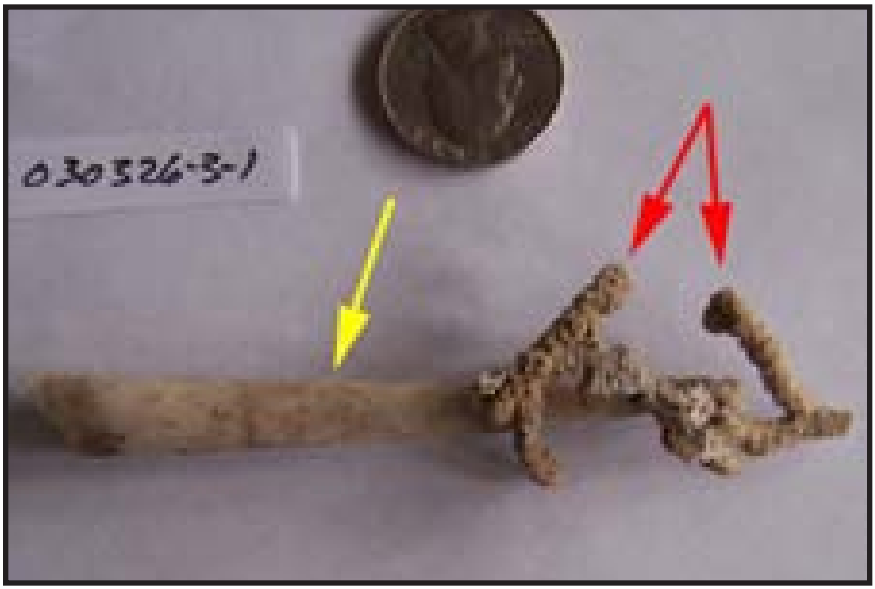
Fossil Identification

- Looks like a hollow tusk
- Most likely found near ridge crests or in the foothills
- In cross section, looks like round tubes

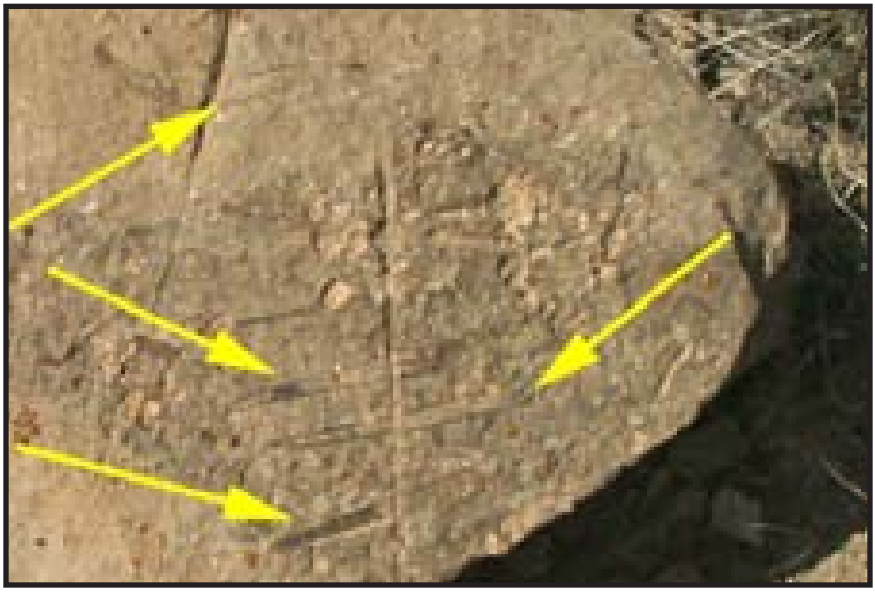
Biological Data

- Living representatives called tusk shells
- Protective shell consists of a long, tapering, hollow tube
- Type of mollusc, burrowing in mud or sand using muscular foot
- Have filaments which capture prey

SCAPHOPODS



Yellow arrow notes scaphopod; red arrows point to attached sponge



SPONGES

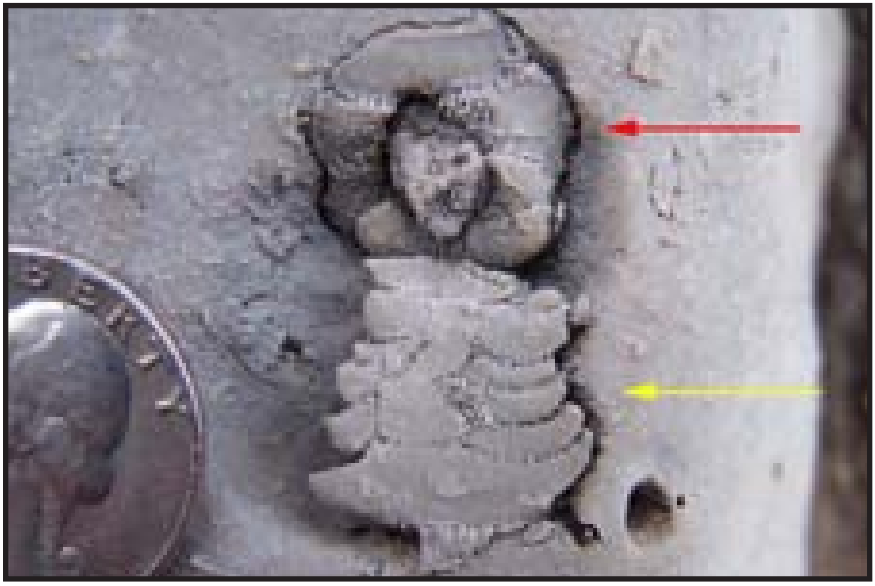
Biological Data

- Members of phylum Porifera, which originated 700 million years ago
- Most primitive of multicellular animals
- Have bag-like bodies open at one end and attached to substrate at the other
- Water enters through minute pores by action of flagella
- Nutrient material suspended in water enters specialized cells for digestion
- Water exits through main opening or several smaller openings
- Over sixty different kinds identified as part of Capitan Reef
- All genera found as fossils in Capitan Reef are now extinct

SPONGES *Amblysiphonella*

Fossil Identification

- Sponges can be found almost anywhere in the park, but are most obvious in the reef high on canyon and escarpment slopes
- Looks like stacked inner tubes
- Common sponge; often found with Lemonea nearby
- Long tubular central canal

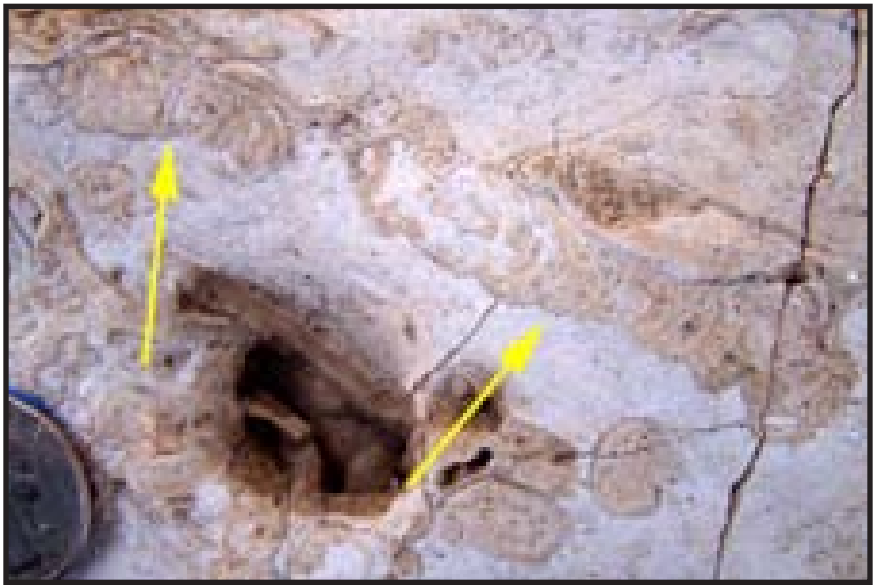


yellow arrow notes stacked inner tube appearance; red arrow points out cross section with central canal

SPONGES *Amblysiphonella*

note stacked rings with central canal

SPONGES *Amblysiphonella*



group of three; weathered, showing characteristic rings

SPONGES

Colospongia

Fossil Identification

- Looks like stack of kidney beans
- No central canal
- Pores in chamber walls
- Fairly uncommon
- Chambers appear more expanded than an amblysiphonella

SPONGES

Colospongia

close up of above photo

SPONGES

Colospongia

SPONGES

Cystauletes

Fossil Identification

- Elongated bubble clusters; about 3/4” or less in diameter
- No central canal
- Side view reveals no more than 3 rows of bubbles
- Fairly common

SPONGES

Cystauletes

SPONGES *Discosiphonella*

Fossil Identification

- Elongated bubble clusters; 1” or more in diameter
- Distinct central canal in cross section
- Side view reveals 5 or more rows of bubbles
- Fairly common

SPONGES

Discosiphonella

Individual with “buds”

SPONGES *Discosiphonella*

cross section

SPONGES *Gigantospongia*

Fossil Identification

- Found at higher elevations, near the top of the reef
- Looks very “spongy”
- Can be large and sprawling; may wrap around the rock
- 1/2 to 1” thick and up to 3 feet long
- No central canal

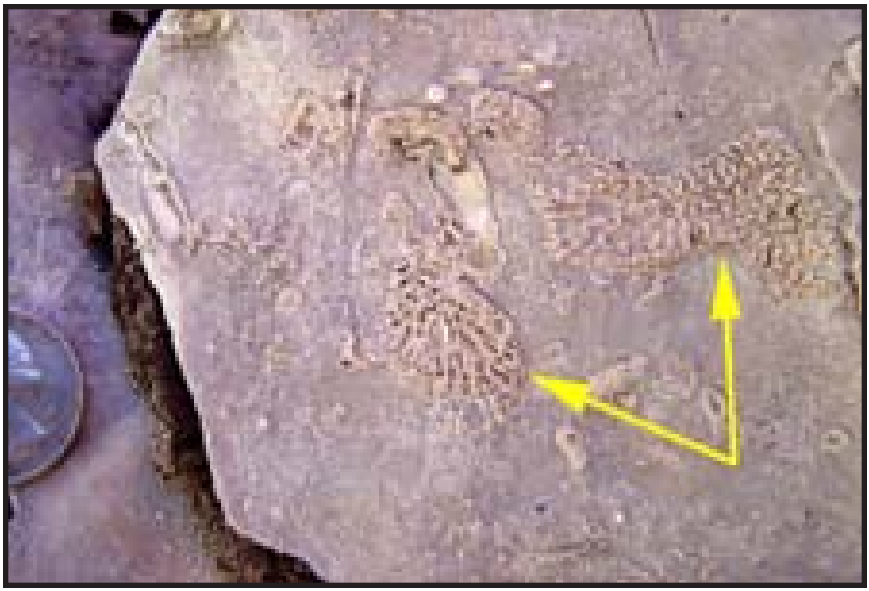
SPONGES

Gigantospongia

giganto bud

SPONGES

Gigantospongia



more young “buds”

SPONGES

Girtycoelia

Fossil Identification

- Single chain of balls; rarely branches
- Small tubular central canal connects the balls
- Relatively uncommon
- Usually found as isolated individuals
- Averages 2” in length

SPONGES

Guadalupia

Fossil Identification

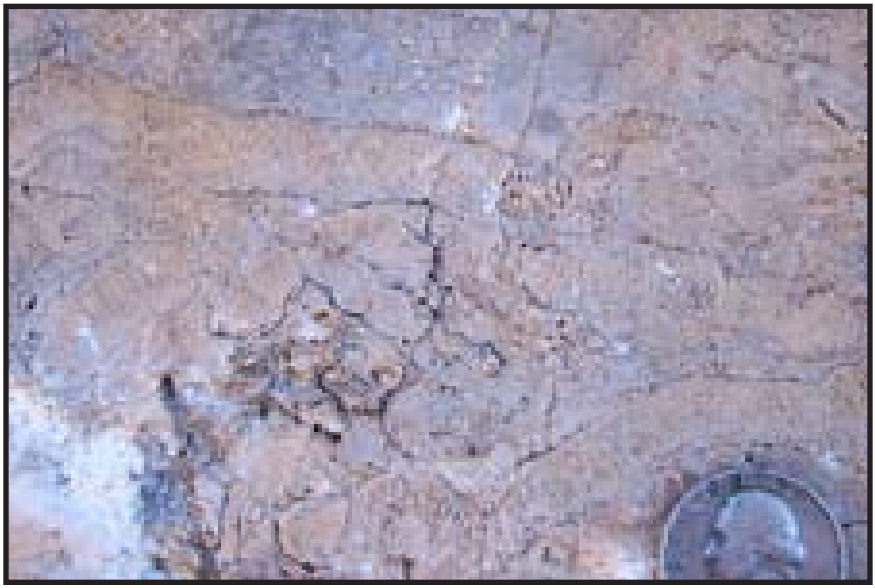
- Can spread to a broad, flat, fan-like shape
- Can look like stacked bananas in cross section
- Exterior looks like a broad patch of fish scales; scales don't change shape at the edges
- Was a flat sponge, as opposed to *Lemonea*, which was cylindrical
- No central canal
- Moderately abundant

SPONGES

Guadalupia

SPONGES

Guadalupia



SPONGES *Heliospongia*

Fossil Identification

- Circular with discontinuous canals radiating out from center
- Small central canal
- Uncommon
- Up to 2 1/2” diameter

SPONGES

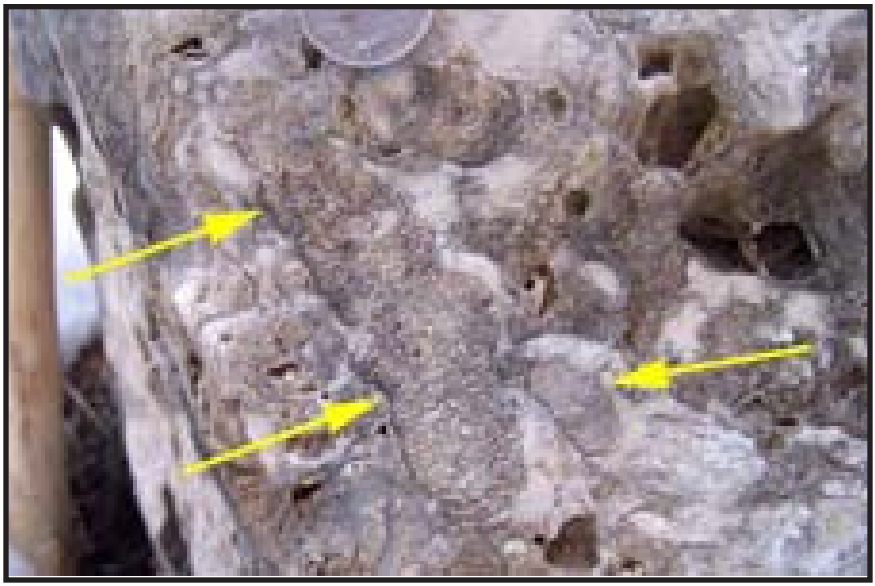
Heliospongia

SPONGES

Lemonea

Fossil Identification

- Cone-shaped or multiple cones connected end to end
- Small chambers which are tightly packed, long, slender, and curved (like very tiny bananas)
- Cross section looks like ring of radiating bananas around central channel
- Channel filled with irregular canals, not sediment
- May form branched colonies
- Average size: ½"diameter; 2 to 8" length; but ranges to 1 ¼" in width to 14" in length
- Most common sponge found in almost any reef elevation



SPONGES

Lemonea

cross section

red arrows note scratch mark defacement

SPONGES

"Race Cars"

Fossil Identification

- Grew near the top of the reef probably in the surf
- Some have corrugated surface appearance
- Tend to be large and bulky; 2 inches or more thick, and very broad
- Uncommon
- Found at higher elevations

SPONGES

"Race Cars"

SPONGES

"Race Cars"

SPONGES

Rhabdactinia

Fossil Identification

- Relatively rare
- Fan-shaped with numerous canals running upwards from base of fan
- Narrow stacked rings of increasing diameter
- If one is found in an area, there may be others nearby

SPONGES

Rhabdactinia

SPONGES

Rhabdactinia

SPONGES

Sheiia

Fossil Identification

- Circular with continuous, very straight, radiating canals
- Very small central canal
- Rare

SPONGES

Sollasia

Fossil Identification

- Chain of small spheres
- No tubular central canal
- Uncommon

SPONGES

Sollasia

Sollasiella

Fossil Identification

- Looks like *Sollasia*, but smaller and chambers are more oval

SPONGES

Unidentified

“earthworm” sponge - cross section of a plate-like sponge

branching type

SPONGES

Unidentified

cross section

a “spongy” sponge

“vase” sponges in cross section

“vase” sponges in cross section

“vase” sponge in cross section

“vase” sponges - arrow indicates individual in vertical section

Vertical section of branching “vase” sponge

TRILOBITES

Fossil Identification

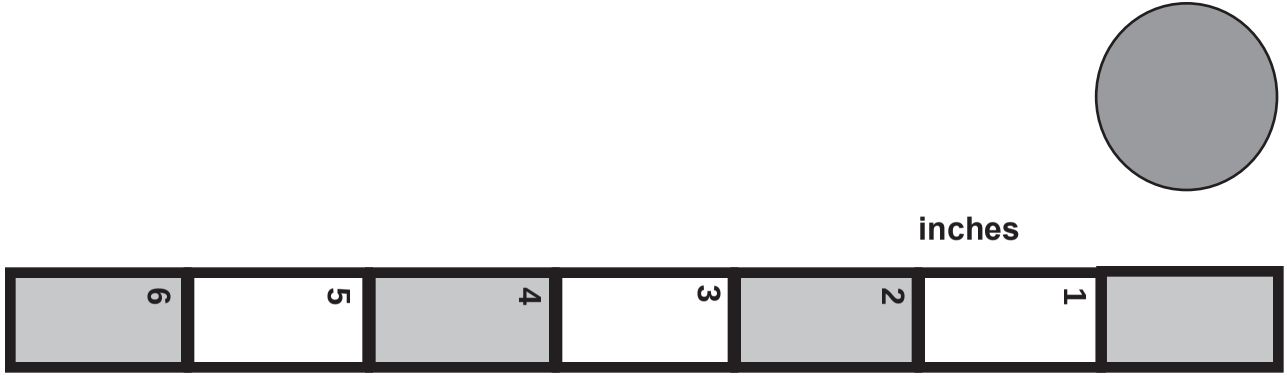
- Rarely found here; if found, note location
- Segmented arthropod

Biological Data

- Type of arthropod with no living descendants
- Lived 600-250 million years ago, ending at Permian Extinction
- Segmented bodies, each segment with two pairs of limbs for walking, swimming, breathing, and handling food
- Predator ranging widely across reef and capturing small prey by stirring up sediment
- Earliest known animal with efficient eyes
- Horseshoe crab probably distantly related

TRILOBITES

Trilobite tail - weathered almost to cross section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